201 DESIGN DEVELOPMENT

201.1 Project File

Document civil design by a set of calculations and drawings that demonstrate the design is both safe and cost effective. The project file is to include information important to the accomplishment of the design. This should include complete written correspondence, summary of telephone calls, design criteria whether furnished by LANL or designer-generated, working notes and calculations. When the design is complete, there shall be a complete historical record showing how the design progressed and reasons for changes.

201.2 Design Calculations

201.2.1 Prepare design calculations. Calculations shall be checked, reviewed, signed, and dated by the designer and the checker, complete in all respects and shall reflect the basis for selection of systems and components.

201.2.2 Submit calculations to LANL for review and approval. This approval does not relieve the AE of any responsibility for correctness and coordination with the drawings and specifications.

201.2.3 The calculations will become record calculations for LANL and may be used in the future for modifications to the building. Room numbers, equipment nomenclature, fixture numbers, zone numbers, or any other designations shall be consistent with those indicated on the drawings or in the specifications.

201.2.4 These calculations will eventually be microfilmed or electronically scanned if electronic copies are not available. For this reason, calculations shall be printed clearly and with sufficient darkness to assure clarity if reproduction or scanning from the microfilm is necessary. Index calculations in a logical order and include adequate sketches to allow an engineer to follow and comprehend them easily.

201.2.5 Note references for unusual formulas or methods of analysis, including edition of the reference and page number. Include explanation of the method used in computer (or calculator) programs, playback of input data, and clear formats for computer-generated information. Clearly identify numbers in formulas as to the units involved; i.e., WP, psi, pcf, etc.

201.2.6 Provide drainage calculations where applicable.

201.2.7 Provide earthwork calculations of cut and fill volumes.

201.2.8 Provide fluid analysis for sizing gas, water, steam/condensate, and sewer systems.

201.2.9 Provide road design calculations including horizontal and vertical alignment, curve data, super elevation, minimum sight distances, and pavement thickness. Take traffic counts and future volume projections (obtained from the Project Management Division Site Planning and Campus Architecture Group) to establish design parameters if required.

201.3 Computer Aided Design

Use the following procedures when automatic Data Processing Systems are utilized to perform design calculations:

201.3.1 Use computer programs approved for use by LANL Project Leader.

201.3.2 Present complete documentation of new programs used. Present this information in fundamental language such that an engineer unfamiliar with the program can understand the functions, limitations, and method of analysis used. Provide sufficient documentation to enable the verification of the method of data input and the interpretation of the output calculations.

201.3.3 Submit plans, flow diagrams, sketches, etc., to completely illustrate the source of input data in such fashion that another engineer can easily check the input data for accuracy.

201.3.4 Present a complete computer listing of input data.

201.3.5 Present a complete computer output listing.

201.3.6 Neatly arrange sketches, input, output, and other material pertinent to the analysis and commit to 8-1/2 x 11 in. sheets, where practical, and include in the complete analysis presentation. Submit the information for review per LANL Project Management established procedures.

201.4 Drawings

Prepare civil drawings in accordance with the LANL Facility Drafting Manual.

201.5 Sealing Construction Documents

Comply with the New Mexico Engineering and Surveying Practice

Act (Chapter 61, Article 23 NMSA 1978). All civil plans, designs, drawings, specifications, or reports prepared by consultants or contractors that are involved in the practice of engineering shall bear the seal and signature of a professional engineer in responsible charge and directly responsible for the civil engineering work.

202 GRADING AND DRAINAGE

202.1 Hydrological Analyses

Perform hydrologic analyses prior to design of drainage within LANL boundaries. Use the Rational Method and the C-factors in Table 202-1 to compute peak flows from small drainage areas for sizing drainage structures. Use the methodologies outlined within the U.S.D.A. National Resources Conservation Service: National Engineering Handbook, Part 630, Hydrology in hydrologic analyses for large off-site drainage areas. Refer to Section 309 (Drainage) of the New Mexico State Highway Department New Mexico Design Manual and U.S.D.A. Natural Resources Conservation Service publication Urban Hydrology for Small Watersheds, Technical Release 55 for further guidance.

In accordance with DOE Std 1020 the potential for flooding must be considered for LANL sites. 100 year and 500 year flood plain levels have been calculated and plotted for drainage basins at LANL, (ESH-18 maintains this documentation). Utilize this information for the evaluation of local flooding potential and surface drainage analysis.

Use the Rainfall Intensity-Duration-Relationship Curve, Figure 202-1, in conjunction with previously described methodologies.

Submit hydrologic analyses to the project file. Drainage submittals should include the following:

202.1.1 Drainage area map showing the location of the site in relation to well-known landmarks.

202.1.2 Description of existing and proposed structures which will influence site drainage.

202.1.3 Hydrologic calculations, including a runoff tabling sheet.

202.2 Hydraulic Design

Design site grading to provide surface drainage to the existing storm drainage system, where possible. Make use of open ditches. Install pipe culverts at all walk (12 in., min.) and road (24 in., min.) crossings. Provide new culverts with appropriate end sections, head walls and erosion-resistant discharge end designs. Provide invert elevations at inlet and discharge end of culverts and percentage of slope for the pipe grade.

Submit hydraulic design calculations, accompanied by preliminary design drawings, to the LANL Project Leader for review and approval.

Refer to the following for guidance:

- *U.S. Department of Interior, Bureau of Reclamation publications Design of Small Canal Structures and Design of Small Dams for appropriate design considerations for open channels and other surface drainage facilities.*
- *American Society of Civil Engineers, Design and Construction of Urban Stormwater Management Systems, 1993.*
- *FHWA Hydraulics publication HDS 5, Hydraulic Design of Highway Culverts.*

202.3 Site Grading

Accomplish site grading in a manner which will cause the least disturbance to the natural terrain. Preserve and protect existing native vegetation and trees and shrubs on or adjacent to the construction site, which do not unreasonably interfere with construction operations. Scalp and stockpile the topsoil within the limits of disturbance for use in landscaping and revegetation operations upon completion of construction.

Establish grades such that site drainage is away from all structural foundations and open utility excavations. In general, surface drainage systems are preferred over closed-conduit systems. Divert roof runoff away from exterior door openings. Consider the effect of water and wind erosion upon the altered drainage patterns adjacent to new structures during design. Design must give consideration to winter shade conditions, i.e., north sides of structures, and heavy vegetation. Take reasonable precautions to preclude the continuation or acceleration of soil erosion at the project site.

Present elevations necessary for proper site grading on the grading plan. Attempt at achieving an earthwork balance during design. If an earthwork balance cannot reasonably be achieved due to existing site conditions, suitable sources of borrow material must be established prior to construction. Coordinate site selection for borrow pit operations with the LANL Project Leader. (See "Excavation Permit Requirements.")

Convey excess material generated during site grading operations to the Los Alamos County sanitary landfill, or other designated locations. Coordinate through the LANL Project Leader.

Specify suitable materials and methods of placing and compacting backfill for buildings, parking areas, roads, loading areas, utility trenches, and the general site within the construction documents.

The grading design shall provide existing and new contours at an interval of 2 ft. and spot elevations shown for grade changes and structure elevations. Provide cross sections where practical and earthwork quantities are substantial. After construction is complete, including clean up, finish grading to the final contours as shown on the drawings shall conform to a tolerance of plus or minus 0.1 ft. Refer to LANL Facility Construction Specifications Sections 02210 and 02220.

202.4 Earthwork

Natural soil shall not have a finished slope steeper than 2 horizontal to 1

vertical (2:1). Undisturbed volcanic tuff shall not have a finished slope steeper than 1 horizontal to 6 vertical (1:6).

Define subgrade preparation as the top 6 in. of site work under slabs and pavement. It shall be scarified, moistened to optimum conditions, and compacted to 95% of maximum density. Limit elevation tolerance to plus or minus .05 ft. per 10 ft. in any direction from specified grade and cross section. Finish slopes may exceed a 2:1 slope in special cases when designed by a registered professional geotechnical engineer.

202.5 Utility Trenches

Trench excavation shall be in accordance with OSHA Standards.

Bed piping with selected granular material to provide protection to the pipe.

Do not complete backfill for underground piping systems until the piping systems have been tested and approved.

Specify the width of trenches for pipe and conduit to be not greater than necessary to permit satisfactory jointing and thorough tamping of the bedding. Excavate trenches in tuff 6 in. below the pipe invert and backfilled to the pipe bottom with sand.

After the pipe has been installed and all testing has been completed, backfill around the pipe with 6 in. of sand and then with selected fill material, at optimum moisture content to the appropriate density in layers not exceeding 6 in. in depth. See Section 202.6 for percentage of maximum density. Take care to ensure thorough compaction of the fill under and around the full length of pipe and the full depth of the trench.

On steeper slopes, approximately 2:1, when compaction is difficult, a flowable fill that will meet general structural requirements, is acceptable.

Refer to LANL Facility Construction Specifications Section 02225 and Civil Drawing ST3211.

202.6 Compaction

Determine optimum density in accordance with ASTM D1557. Determine field control of density of in-place material in accordance with the Nuclear Method ASTM D2922; or the relative density of cohesionless soils ASTM D4253; and field control of moisture content will be determined by the Nuclear Method ASTM D3017, or the Laboratory Determination ASTM D4253 for cohesionless material.

Comply with the following compaction requirements for approved material,

moistened to optimum conditions, and placed in layers not to exceed 6 in., before compaction.

% of Maximum Density	Type of Material
95	Structural fill, embankment, backfill, subgrade and base course under building floor slab, concrete sidewalks, and paved areas.
90	General area grading, backfill, and embankments not under paved area.
85	Sand bedding for underground piping system, except under roadways where density shall be 95%.

Refer to LANL Facility Construction Specifications Section 02220.

202.7 Archaeological Clearance

Comply with ESH-20 process through the ESH I.D. System.

202.8 Erosion Control

Native vegetation must be reestablished in all areas disturbed by construction activity. The primary objective of revegetation efforts is the mitigation of site erosion. Mulching and seeding should commence immediately following completion of construction operations.

Stabilize soil slopes (except undisturbed tuff) steeper than 2 horizontal to 1 vertical (2:1) using rock rip-rap, concrete, anchored fabric seeded with native grasses, native shrubs, or other erosion control materials to prevent soil erosion. Stabilize soil slopes less than 3 horizontal to 1 vertical (3:1) that have been disturbed during construction with native seed mixes. Refer to New Mexico State Highway and Transportation Department Standard Specifications for Highway and Bridge Construction.

Refer to LANL Facility Construction Specifications Sections 02240 and 02270.

Figure 202-1

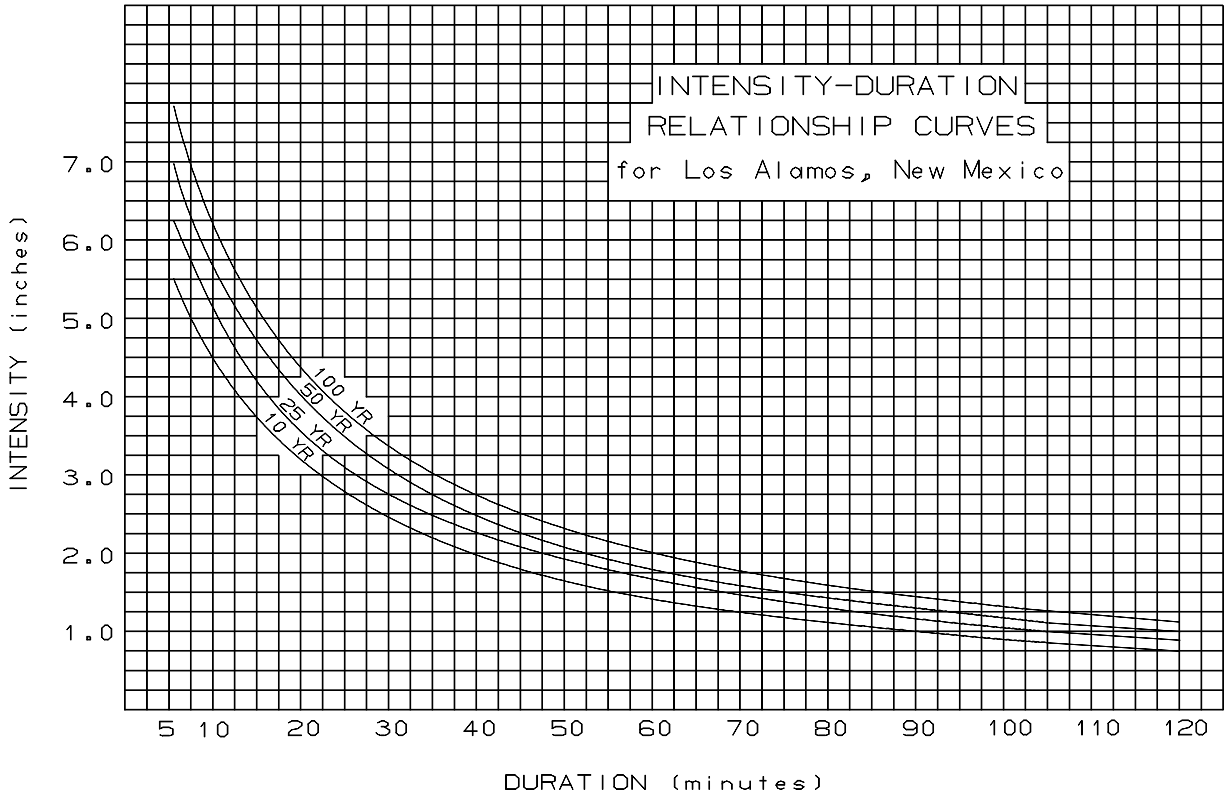
INTENSITY-DURATION
RELATIONSHIP CURVES
for Los Alamos, New Mexico
100 YR
50 YR
25 YR
10 YR
INTENSITY (inches)
7.0
6.0
5.0
4.0
3.0
2.0
1.0
5 10 20 30 40 50 60 70 80 90 100 110 120
DURATION (minutes)

Table 202-1

Use the following C-factors in conjunction with the Rational Method. (New Mexico State Highway Department - Hydrology Section).

URBAN

Residential-lawns	Flat	.05-.15
	Steep	.35
Suburban		.25-.40
Single-family		.30-.50
Multifamily		.40-.60
Apartments		.50-.70
Business	Downtown	.70-.90
	Neighborhood	.50-.70
Industrial	Flat-commercial	.80
	Heavy-commercial	.50-.80
	Light-commercial	.50-.80
Streets	Asphalt concrete	.70-.95
	Portland concrete	.80-.95
	Gravel, shoulders	.40-.60

RURAL

Subtract the given numbers from unity; interpolate when appropriate.

TOPOGRAPHY			SOIL			COVER		
FLAT	ROLLING	HILLY	TITE CLAY	MED C-L	OPEN S-L	BARREN	CULT	WOODS
.3	.2	.1	.1	.2	.4	.0	.1	.2

203 ROAD, PAVEMENT, AND PARKING LOT DESIGN

203.1 Street Design

The fundamental approach to street design is to first identify the design speed the facility is to accommodate, the nominal vehicle type which is to govern the design and the road classification such as aerial, collector, etc. Design is then accomplished by selection of appropriate characteristics to accommodate the design vehicle at the design speed in a safe and efficient manner at reasonable cost on a durable street. Posted legal speeds will be established by the LANL Traffic Advisory Committee after appropriate examination of the completed street. Refer to Table 203-1: General Design Criteria for Streets and Civil Drawing ST3501.

203.2 Parking, Paved Storage, and Service Areas

Provide for erosion and drainage control, prevention of frost damage, ease of maintenance, and a reasonably dust-free surface. Provide impervious surfaces with proper drainage in storage areas to prevent moisture penetration into the base course and subgrade.

203.2.1 Provide parking for employee, visitor, government, and handicap vehicles.

203.2.2 Provide paving for parking lots and service areas the same as for road design.

203.2.3 *Bumper blocks and guard rails are usually not appropriate in parking lots due to snow removal concerns. Stripe parking areas, with appropriate signs installed.*

203.2.4 Provide parking areas with a maximum gradient of 5% and a minimum gradient of 0.05%. The maximum and minimum grades are to be used only where more desirable grades prove very uneconomical and difficult to obtain. Design toward the average range of the grades.

203.2.5 Refer to Civil Drawing ST3504 for parking layout.

203.3 Classification of Roads

203.3.1 Arterial

- East Jemez
- West Jemez
- Pajarito Road
- Diamond Drive (with right-of-way restrictions)

203.3.2 Collector Roads

- Pecos
- La Mesita
- Mercury
- Eniwetok
- Puye
- Bikini

203.4 Geometric Design Criteria

203.4.1 The following subsections present geometric design criteria for new roadways to be constructed within LANL boundaries. General Design Criteria for Streets (in these standards), generally summarizes the minimum values acceptable for geometric street design; however, other factors must also be taken into consideration to achieve a balanced design. Refer to AASHTO Policy on Geometric Design of Highways and Streets (GDHS-2) for passing sight distance design criteria for 2-lane highways.

203.4.2 As a general design principle, the minimum desirable gradient consistent with acceptable drainage is 0.5%. Service road and driveway gradients should not exceed 8%.

203.4.3 Provide a normal crown, as shown in Civil Drawing ST3501, on internal streets to promote control of drainage and nuisance flows. Due to local terrain and climatic conditions the maximum rate of superelevation shall not exceed 4% within LANL boundaries.

203.5 Drainage Considerations

Provide, where possible, crown configuration and transitional reaches of pavement surfaces to minimize traffic interference by drainage flow.

203.6 Intersection Design for Streets within LANL Boundaries

203.6.1 Provide streets to intersect at right angles as local topography will allow. Where unusual circumstances require the use of acute angles at street intersections, these angles shall not be less than 80 E.

203.7 Intersection Grading

Intersection grading must provide characteristics consistent with the design speed of the through street. Curb flowline profile projections through intersections will be required for major intersection designs

which involve internal collector streets.

203.7.1 Minor leg intersection approach tangent gradients shall not exceed 4 % for a distance of at least 50 ft. back from the projected curb flowline of the through street.

203.7.2 Reduce street crowns through the intersections of major streets of approximately equal classification to promote comfort, however, crown reduction should not exceed one half of the standard crown. Intersection grading must provide for rapid drainage. Crown should consider roadway with major flow of traffic to set priority on size.

203.7.3 Intersection designs shall provide for clear sight distances design.

203.8 Curb and Gutter

Provide curb and gutter with 6 in. high barrier type curb and gutter and 1 1/2 in. gutter depth. Use this curb and gutter section for all internal corridors, collectors and internal streets within LANL boundaries.

If traffic and drainage requirements can be met to the satisfaction of these guidelines, mountable curb types may be used on parking lots where snow removal operations may cause damage.

203.9 Pavement Structures

Currently acceptable design procedures include AASHTO Guide for Design of Pavement Structures, Vol-2 (GDPS4-V2) and the local adaptation of those procedures developed by the New Mexico State Highway Department entitled Structural Design Guide for Flexible Pavement, NMSHD Bulletin 102.

Acceptable design procedures require investigation and evaluation of subgrade soils and traffic data including estimated percentage of heavy vehicles. Provide such data with design submittals.

Roadways of pavement structure designs shall conform to HS-20 Highway Loading. Any deviations for HS-20 Highway Loadings must be approved by Facilities Utilities Group. Subgrade soils investigation and evaluation will be required to determine the bearing values of the proposed subgrade soils. The standard pavement section is calculated with the Hveem Stabilometer Method Test (R-Value) for the subgrade soil.

203.10 Pavement Materials

Comply with the New Mexico State Highway and Transportation Department Standard Specifications for Highway and Bridge Construction.

203.10.1 Asphalt paving will consist of a minimum of 3 in. Plant Mix Bituminous Pavement (PMBP) on top of 6 in. aggregate base course on a prepared subbase with an optional tack coat.

203.10.2 Portland Cement Concrete. Design criteria outlined within the New Mexico State Highway Department Standard Specifications are to be used in the structural design of Portland Cement concrete pavements.

203.10.3 Construct exterior sidewalks, curbs, gutters, utility pads, and chases of air-entrained concrete, f'c = 4,000 psi.

203.11 Traffic Signs

Select and locate traffic signs in accordance with the Manual on Uniform Traffic Control Devices (MUTCD).

Table 203-1
GENERAL DESIGN CRITERIA FOR STREETS

STREET CLASSI-FICATION	DESIGN SPEED M. P. H.	MINIMUM CENTERLINE RADIUS - FEET (5)		MINIMUM LENGTH VERTICAL CURVE (Ft.) (1)	VERTICAL CURVE REQUIREMENTS (4) VERTICAL CURVATURE DESIGN VALUE K (2)			MAXIMUM GRADE CHANGE ALLOWED WITHOUT VERTICAL CURVE-% (8)	MAXIMUM GRADE ALLOWED %
		WITH 0.02 FT./FT. SUPER ELEVATION	WITH NORMAL CROWN (7)		FOR CREST STOPPING SIGHT DISTANCE (6)	FOR SAG STOPPING SIGHT DISTANCE (6)	FOR SAG COMFORT CONTROL (3) (6)		
PRINCIPAL ARTERIAL	50	1,050	1,400	150	100	75	N/A	0.4	6
MINOR ARTERIAL	45	800	1,100	135	80	65	N/A	0.4	7
COLLECTOR	35	450	575	100	46	45	26	0.7	8
MAJOR LOCAL	30	300	380	100	32	35	19	0.8	8
LOCAL RESIDENTIAL	25	---	(9) 230	75	25	28	13	1.0	8
LOCAL RESIDENTIAL CUL DE SACS & ALLEYS	20	---	(9) 120	60	18	24	9	1.0	8
LOCAL INDUSTRIAL COMMERCIAL	30	300	380	90	32	35	19	1.0	8
LOCAL-LEG OF "T" INTER-SECTION	15	N/A	N/A	45	5	9	5	1.0	8

Footnotes:

(1) Controlling limit only when algebraic grade difference (A) times the design value K is less than minimum shown: in all other cases, L = KA shall control.

(2) The values for K shown are to be used in determining the minimum length of vertical curve required by the use of the relationship L = KA where:
L = Length of vertical curve in ft.
A = Algebraic difference in grades expressed in %
K = Design value indicative of rate of curvature

(3) Allowed only with express permission of the LANL Facilties Division Traffic Engineer.

(4) Lengths of vertical curves longer than the minimums resulting from the use of K values shown should be used wherever possible; however, K should not exceed 143 ft. when curb and gutter is used.

(5) Source: Design or Urban Streets, Federal Highway Administration, U.S. Department of Transportation.

(6) Crest vertical curves are based on eye height of 3 ft.-3 in., object height of 6 in. and AASHTO, minimum stopping distances. SAG vertical curves are based on AASHTO standards. If AASHTO standards are revised to more restrictive values, the more restrictive values shall supersede the values in this table.

(7) As given in Civil Drawing ST3501.

(8) A minimum of 50 ft. must be maintained between vertical points of intersection.

(9) Local streets with 90 E or near 90 E turns may be designed with a minimum centerline radius of 75 ft. with the approval of the FWO Division. Appropriate advisory signs may be required.

204 UTILITIES

204.1 General

Include in the design of site utilities the most economical and feasible plan for bringing utilities to the site to meet service criteria for the project. Utility plans must be reviewed by the FWO Division Utilities and Infrastructure Group.

Connections to existing utility mains shall be made by LANL's Support Services Subcontractor. The construction contractor shall furnish required materials for final connection to utility "mains".

Install 6 in. wide reinforced plastic color coded identification tape 12 in. below finished grade. The type of utility shall be indicated on the tape. Provide a tracer wire for non-metallic and ductile iron utilities. Refer to Civil Drawing ST3211 and Mechanical Drawing ST6109.

205 SANITARY SEWER DESIGN

This subsection presents the requirements, standards and regulations related to the design of sanitary sewerage systems for general service. It does not cover the requirements necessary for design of major interceptor sewers, lift stations, or treatment facilities. Provide double wall industrial liquid waste lines. Provide sampling manholes near the point of discharge to allow measurement of flow rates and pH. Coordinate designs for industrial and hazardous liquid waste lines and manholes with ESH Division Hazardous and Solid Waste Group. *For guidance, refer to American Society of Civil Engineers publication Design and Construction of Urban Stormwater Management Systems.*

205.1 Capacity

205.1.1 In areas with an office and industrial mix, roughly representative of the LANL as a whole, the population of the contributing area is determined and the design flows are calculated to be 35 gal. per capita per day, minimum. Special facilities may require more sophisticated sanitary sewer design flow/volume calculations.

205.1.2 Determine population loadings for each job. *Refer to the New Mexico Environmental Department Liquid Waste Disposal Regulations for further guidance in the determination of population loadings and design flows.*

205.1.3 Design for pipe to flow a maximum of one-half full.

205.1.4 Use Manning's Formula for determination of pipe flow velocities and capacities. Use a Manning's "n" value of 0.013 in calculations performed to determine the following:

- Peak velocity = Velocity at peak flow conditions
- Average velocity = Velocity at average flow conditions
- Minimum cleansing velocity (2 fps).
- Refer to Table 205-1: Minimum Sewer Main Slopes, for slope criteria.

205.2 Manholes

Comply with the following manhole criteria for sewer systems within LANL boundaries:

205.2.1 The distance between manholes for 8 to 21 in. sewers is 450 ft. maximum.

205.2.2 The distance between manholes for 24 in. and larger sewers is 500 ft. maximum, for average velocities 3.0 fps or less.

205.2.3 The distance between manholes for 24 in. and larger sewers is

800 ft. maximum, for average velocities greater than 3.0 fps.

205.2.4 Manholes are required for changes in horizontal sewer alignment.

205.2.5 Manholes are required for abrupt changes in vertical sewer alignment (drop manholes).

205.2.6 Manholes are required for 6 in. service connections to 8 in. mains when there are no existing tees in the sewer.

205.2.7 Manholes are required for service connections 8 in. and larger when there are no existing tees of the required size in the sewer.

205.2.8 Manhole depths shall not be less than 6 ft., as measured from rim to invert, without prior approval of the Facilities Utilities Group.

205.2.9 The manhole shall have a minimum inside diameter of 4 ft.

205.2.10 The manhole shall have a shelf, with a minimum width of 9 in. on each side of each main line within the manhole.

205.2.11 Where the primary flow changes direction within a manhole, the manhole must be of a sufficient size to accommodate a centerline radius of curvature of the flow invert larger than the pipe diameter.

205.2.12 In general, do not exceed 90^{o} changes in horizontal flow direction within manholes. The maximum change in horizontal flow direction shall not exceed 50^{o} when the following circumstances prevail:

- Sewers that are larger than 36 inches in diameter.
- Continuous sewers that have a design flow greater than 3.0 MGD and a design velocity of 5.0 fps or greater.
- Sewers that have a junction of two flows, each with design flow greater than 3.0 MGD, where one sewer has a design pipe velocity of 5.0 fps or greater.

205.2.13 Note invert elevations for each inlet and outlet to a manhole on construction drawings.

205.2.14 Provide drops across manholes where the primary flow does not change direction at the manhole. Provide a slope across the manhole at least equal to the average of the slopes of the incoming and outgoing sewers, with a minimum drop of 0.10 ft.

provided for sewers 18 in. in diameter and smaller.

205.2.15 Provide drop across manholes where flows converge at a manhole. Design the inverts to produce a smooth water surface at design flow with no backwater conditions in any of the incoming sewers. Excessive drops which cause turbulence are to be avoided.

205.2.16 Refer to Civil Drawing ST3732, Precast Concrete Manhole.

205.3 Sewer Lines

205.3.1 Minimum allowable sewer size: 8 in. inside diameter (exception: appropriately size service laterals for the facility being served).

205.3.2 Use Table 205-1 showing minimum slopes required for noncurvilinear sewers to ensure that minimum allowable velocities are maintained in these standards. GREATER SLOPES THAN MINIMUM ARE DESIRABLE AND ARE TO BE PROVIDED WHERE POSSIBLE. Slopes which may result in the development of super-critical flow conditions within the sewer are unacceptable.

205.3.3 Abrupt changes in grade and slopes opposite to the direction of flow are unacceptable.

205.3.4 Provide two-way cleanouts on sanitary sewer service lines. Provide a gravity type system unless elevation differences prevent this solution. Provide a lift station only when gravity flow is not possible or feasible. Refer to Mechanical Drawing ST6010.

205.3.5 Comply with the following for new sanitary sewers and service laterals criteria:

Where feasible, do not route sewers or force mains within 10 ft. of potable waterlines or firelines.

Where potable waterlines must cross sewers or force mains, waterlines shall pass 2 ft. above the sewer or force main. Where insufficient cover precludes such vertical separation, provide ductile iron pipe sewer or force main or encase sewer line in concrete for a minimum distance of 10 ft. to each side of the waterline crossing.

If ductile iron pipe is used, a continuous run from manhole to manhole must be provided.

Locate sewers such that they can be maintained without disturbance of existing or future facilities.

205.4 Curvilinear Sewers

205.4.1 Curvilinear sewers must be approved by the Facilities Utilities Group.

205.4.2 The minimum radius of curvature is 200 ft. based on pipe lengths of 5-1/2 ft. A smaller radius of curvature may be acceptable, if shorter pipe lengths are available.

205.4.3 Do not exceed 300 ft. distance between manholes.

205.4.4 Curvilinear sewer slopes must be at least 5 % greater than the upstream straight line sewer. Use Table 205-2 for the "Minimum Slope Criteria for Curvilinear Sewers".

205.5 Service Laterals

205.5.1 Connect 4 in. service laterals directly to sewers. Four inch service lateral connections into manholes are not allowed except when sewers terminate at the end of any possible expansion (end of mesa, dead-end roadway, etc.).

205.5.2 Six inch service lateral connections are permitted where a 6 in. tee exists in the sewer.

205.5.3 Four inch and 6 in. mechanical taps are permitted to tappable 10 in. and larger sewers. Mechanical taps are required where tees are not available in the existing sewer.

205.5.4 Make 6 in. service lateral connections to 8 in. sewers and all service lateral connections 8 in. and larger by means of a manhole when there are no existing tees of the required size in the sewer. Insertion of a full joint of pipe containing a factory made tee will be permitted, if practical, for purposes of connecting a 6 in. service to an existing 8 in. sewer. Provide approved coupling devices. Service connections to a manhole are to be made with the invert of the service lateral at the elevation of the top of the sewer. No inside manhole piping is permitted.

205.5.5 Construct service connections without bends unless cleanouts are installed as approved by the FWO Division Utilities and Infrastructure Group.

205.5.6 Provide service laterals with a minimum slope of 1/4 in. per ft.

between the sewer and the facility being served. Provide a minimum depth of cover of 4 ft. at the edge of pavement or within 30 ft. of the structure. Ensure service drains inside buildings are not lower than the manhole rim of the sewer main into which they drain.

Table 205-1

MINIMUM SEWER MAIN SLOPES

SEWER I.D. (inches)	MINIMUM SLOPE (ft/ft)
8	0.0060
10	0.0028
12	0.0022
15	0.0015
18	0.0012

Table 205-2

MINIMUM SLOPE FOR CURVILINEAR SEWERS

SEWER I.D. (inches)	MINIMUM SLOPE (ft/ft)
8	0.0066
10	0.0030
12	0.0024
15	0.0018

206 ON-SITE WASTEWATER TREATMENT AND DISPOSAL SYSTEM DESIGN

Tie new facilities to the existing Sanitary Wastewater Collection System for the efficient and economical disposal of sanitary wastewater. Consider on-site wastewater treatment and disposal systems only when tying to the existing system is not feasible or proves to be unreasonably expensive.

206.1 Design Criteria

206.1.1 Design for on-site treatment and disposal systems must be approved by LANL's ESH Environmental Surveillance Group and the FWO Division Utilities and Infrastructure Group prior to design.

206.1.2 Use a separate collection system for industrial hazards and toxic wastes to keep them separate from the sanitary waste water system. Do not use a septic tank system or other on site disposal system to dispose of industrial, hazardous, or toxic waste.

206.1.3 Collect industrial toxic, hazardous, and oily waste water in a holding tank and haul or pipe to a chemical treatment plant for subsequent treatment and disposal.

207 WATER SYSTEM DESIGN

This subsection presents the criteria, standards and regulations related to the design of water distribution systems for general development service. It does not cover the criteria necessary for design of major transmission lines, wells, pumping facilities, or reservoirs.

207.1 General

207.1.1 The sizing and routing of LANL water lines must be coordinated with and approved by the FWO Utilities and Infrastructure Group.

207.1.2 Consider applicable pressure boundaries in the design of systems.

207.1.3 Provide a distribution line in all streets.

207.1.4 Provide the minimum of 4 ft. of cover for freeze protection on water lines except irrigation systems with automatic drain valves.

207.1.5 Inspect and test new water lines in accordance with the requirements in the LANL Facility Construction Specifications Section 15992 and NFPA 24.

207.1.6 Comply with the New Mexico Drinking Water Regulations, Title 20, Chapter 7, Part 1.

207.2 Line sizing

207.2.1 Loop distribution lines where economically feasible.

207.2.2 Size fire protection lines for internal fire protection systems or hydrants. Minimum size for fire protection lines shall be 6 in.

207.3 Water Line Designations

207.3.1 Distribution lines provide local distribution of water and extend service to individual users. Distribution lines are sometimes referred to as "main lines" or "mains." Service connections to distribution lines shall be made by LANL's Support Services Subcontractor. The construction contractor shall provide materials necessary for service connections.

207.3.2 Service lines are those lines which provide service from a local distribution line directly to the user's meter.

207.3.3 Provide fire protection lines in accordance with NFPA 24, and appropriately size to meet fire demands. Provide fire protection

lines with an FM approved or UL listed gate valve and PIV assembly, do not meter. The minimum depth of cover for fire lines shall be 4 ft. Provide cathodic protection on metallic piping except ductile iron piping.

Perform necessary fire flow tests to establish distribution system capabilities prior to design of fire protection lines. Arrange for fire flow testing with the FWO Division Fire Protection Group.

207.3.4 Potable water service connections shall be a minimum of 10 ft. upstream, if possible, of any controlling valves for fire protection systems.

207.3.5 Provide fire hydrants, valves, pressure reducing valves, bollards, post indicator valves and other appurtenances according to NFPA standards and as required for standard operations of the water system. Looping of water mains is recommended where possible. Refer to Civil Drawings ST3011, ST3633, ST3665, and applicable Mechanical Drawings.

207.3.6 Hydrostatically test new water supply lines according to NFPA-24 and disinfected in accordance with the LANL Facility Construction Specifications Section 15470. Notify ESH-18 prior to discharging water to ground, for compliance with surface water discharge regulations. Refer to Chapter 6, Mechanical, Section 204.30 and 204.31.

208 NATURAL GAS

208.1 General

Coordinate site gas service installations with the FWO Division Utilities and Infrastructure Group.

Design natural gas service in accordance with 49 CFR 192, Transportation of Natural and Other Gas by Pipelines, Minimum Federal Safety Standards and ASME B31.8, Gas Transmission and Distribution Piping Systems.

Refer to LANL Facility Construction Specifications Section 15195 and Civil Drawing ST3211.

209 STEAM/CONDENSATE

209.1 General

Coordinate steam service connections to the distribution piping with the FWO Division Utilities and Infrastructure Group.

Steam Distribution Piping: Steam piping upstream of the first steam shutoff valve, including valve, inside the building or steam pit shall comply with ASME B31.1, Power Piping.

Condensate Distribution Piping: Condensate piping upstream of the first steam shutoff valve inside the building or steam pit, including the steam trap piping upstream of the first steam shutoff valve shall comply with ASME B31.1, Power Piping.

Refer to LANL Facility Construction Specifications Sections 15520 and 15525, and Civil Drawing ST3211.

210 ACCESS AND SECURITY CONTROL

210.1 General

Obtain approval of the physical protection system from the Laboratory's Safeguards and Security Division (S).

For secured facilities requiring a security fence refer to the Civil Security Fence Drawings ST3831.

211 SURVEYING

211.1 General

The degree of accuracy for construction, control, property, and topographic (including existing structures and utilities) surveys shall be consistent with the nature and importance of each survey. Where required by law (i.e., applicable State statutes) control and property surveys at LANL shall be performed by, or under the supervision of, a professional land surveyor registered in the State of New Mexico.

Conform to Table 211-1 for specific survey categories.

Due to security restrictions and hazardous conditions at some LANL sites, surveyors must contact appropriate divisional personnel, Facility Managers for Work Control Procedures, and ESH authorities to obtain necessary escorts and training.

211.1.1 Permanent Survey Monuments

Coordinate the placement, number and location of permanent survey monuments for horizontal and vertical control with and approved by the LANL Project Leader and Facilities Management Unit. Provide the location and description of the nearest permanent survey monument on construction drawings. Tie these monuments by Grid Bearing, ground distance and elevation to the New Mexico Coordinate System and referenced to NAD of 1983 and the NGVD of 1929.

Any surveyor that sets a permanent survey monument shall prepare legible notes, sketches, or other reproducible documentation that show the location of the new monument relative to the on-site horizontal and vertical control network to the applicable New Mexico Coordinate System, to the NAD of 1983, and to the NGVD of 1929. Provide the convergence, scale factor and elevation at the monument. Coordinates for NAD 83 shall be in ft.

A description of the surveying equipment and procedures used to establish the new monument shall accompany copies of field notes, calculations, reductions, and closures. Submit similar information for any found monuments. Consider permanent survey monuments properly positioned and represented only after the FWO Division has approved survey procedures and calculations and has verified conformance to standards and specifications for Order 2-I surveys or greater.

Identify permanent survey monuments with a metal cap set in conformance with National Geodetic and New Mexico Survey Practice. Permanently stamp identification numbers into the metal cap.

Document these identification numbers within the survey field notes and shown on the design drawings and within related documents.

Tentative point identification for permanent survey monuments may be assigned by the surveyor: however, permanent point identification must be assigned and recorded according to these standards.

Install two steel angle guard posts painted white adjacent to permanent control monuments in high traffic areas to preclude vehicular damage as per standard detail contained herein. Do not remove permanent survey monuments without prior authorization from FWO Division Utilities and Infrastructure Group.

211.1.2 Bench Marks

Establish a minimum of one permanent bench mark for vertical control in each new development area. Establish a minimum of three bench marks if there are no existing bench marks within a 3-mile radius of each new development area. Additional bench marks may be established, as necessary. Bench marks may coincide with permanent survey monuments or temporary control monuments.

Reference bench mark elevations to the NGVD of 1929.

Level section misclosures between fixed bench mark elevations shall equal or exceed Third Order Accuracy, as defined in FGCC Standards and Specifications for Geodetic Control Networks and shown below.

Accuracy Standards for Level Closures

First Order*	Second Order*	Third Order*
0.017 ft $M^{1/2}$	0.035 ft $M^{1/2}$	0.05 ft $M^{1/2}$

* M is the distance in miles of the total level route running forward and back between fixed elevations or along a level loop.

Source: Standard and Specifications for Geodetic Control Networks, Federal Geodetic Control Committee.

Legible level notes or electronic data and calculations shall be prepared by the surveyor.

Identify permanent bench marks with a metal cap as specified

in Section 211.1.1, Permanent Survey Monuments.

Do not remove permanent bench marks without prior authorization of FWO Division Utilities and Infrastructure Group. Provide the location of description of bench marks in the immediate vicinity of new construction on construction drawings.

211.2 Surveys for New and Existing Utilities, Roads, and Parking Areas

Determine coordinates and elevations for utilities, roads, and parking areas at their principal points of definition. Provide this information on the construction drawings.

The principal points of definition for utility systems shall include utility poles, obstructions, manholes, valve boxes and other appurtenances for heating and cooling lines, sewers, and overhead and underground power and communication/data systems. Principal points of definition for potable water and natural gas distribution systems shall be valve boxes, main line intersects, fire hydrants, and other appurtenances.

The principal points of definition for roads shall be roadway centerline intersects. Road alignment surveys shall include stationing, bearings and curve information tied to these principal points of definition. Where applicable, provide the following information on the construction drawings:

211.2.1 Stations and deflection angles for each point of intersection.

211.2.2 Right-of-way lines and markers.

211.2.3 Spot elevations (centerline, edge of pavement, top of curb, gutterline at curb returns, valley gutters, and at intersects) at minimum intervals of 100 ft.

211.2.4 Pavement width and curb and gutter width where applicable.

211.2.5 Other improvements (e.g., drainage inlets/outlets, wheelchair ramps, fire hydrants, sidewalk, curb and gutter).

211.2.6 Topographic features within the project limits.

211.2.7 Elevation contours.

211.2.8 Overhead and underground utility crossings (plan and profile).

211.2.9 Roadway drainage crossings (angular or perpendicular to roadway).

211.2.10 Location and description of underground utility witness markers.

211.3 Surveys for Location of Existing Underground Utilities

Where exact routes of underground utilities are not defined within record drawings and such information is essential to subsequent design efforts, the surveyor shall coordinate necessary electronic line detection and exploratory excavation activities with the LANL's Support Services Subcontractor. Locate such utilities by survey and document on the construction drawings. Principal points of definition shall be the same as in section 211.2.

211.4 Survey Information Submittal

Record surveys in field books or electronic files.

Submit information gathered from surveys for sampling, utilities, roads, parking areas, structures, and control to the infrastructure As-built Program to become a part of the LANL GIS Database using the Procedures outlined in the Survey Procedures of this section.

Table 211-1
Geometric Relative Positioning Accuracy Standards for Three-Dimensional Surveys Using Space System Techniques

Survey categories	Order	(95 % confidence level) Minimum geometric Accuracy standard		
		Base error	Line-length Dependent error	
		e (cm)	p (ppm)	a (1:a)
Global-regional geodynamics; deformation measurements	AA	0.3	0.011	:1000,000,000
National Geodetic Reference System, "primary" networks; regional-local geodynamics; deformation measurements	A	0.5	0.1	: 10,000,000
National Geodetic Reference System, "secondary" networks; connections to the "primary" NGRS network; local geodynamics; deformation measurements; high-precision engineering surveys	B	0.8	1	: 1,000,000
National Geodetic Reference System (Terrestrial based); dependent control surveys to meet mapping, land information, property, and engineering requirements	1	1.0	10	1: 100,000
	2-I	2.0	20	1: 50,000
	2-II	3.0	50	1: 20,000
	3	5.0	100	1: 10,000

Note: For ease of computation and understanding, it is assumed that the accuracy for each component of a vector base line measurement is equal to the linear accuracy standard for a single-dimensional measurement at the 95 % confidence level. Thus, the linear one-standard deviation(s) is computed by:

$$s = +/-\langle e + (0.1dxp)_2 \rangle /1.96$$

Where, d is the length of the baseline in kilometers.

This table is taken from "Geometric Geodetic Accuracy Standards and Specifications for Using GPS Relative Positioning Techniques."

212 SITE IMPROVEMENTS

212.1 Walks, Paths

Meet the provisions of 28 CFR 36, Appendix A, Americans With Disabilities Act Accessibility Guidelines (ADAAG) for parking and access into the building.

212.2 Fences and Gates

Provide security fences and gates where required and as per Civil Drawings ST3831.

213 STORM WATER MANAGEMENT FOR CONSTRUCTION ACTIVITIES

213.1 Criteria

This section provides design standards for storm water pollution prevention for all construction work which disturbs soil at LANL.

All projects, regardless of size, must utilize appropriate “Best Management Practices” (BMPs) to control the discharge or migration of pollutants, including sediment, into a watercourse. These BMPs are required to avoid violation of the New Mexico Water Quality Control Commission stream standards for turbidity and sedimentation. Designers of projects disturbing over 5 acres of soil are also required to prepare a written Stormwater Pollution Prevention Plan (SWPPP) in addition to designing BMPs. Follow Table 213-1: Responsibility Matrix, and Table 213-2: Sediment Entrapment Facility Limitations, for criteria.

213.2 Small Sites - Under Five Acres of Disturbance

Incorporate appropriate BMPs into the Grading and Drainage Plans for small sites (disturbing less than 5 acres).

213.2.1 Small Site Minimum Stabilization Controls

Seed and mulch disturbed soils. Utilize matting on fill slopes 3:1 or steeper. Repeat seeding, if necessary, until the vegetation density reaches at least 70 % of the density found on similar undisturbed sites (Use BMP per SWPPP).

213.2.2 Small Site Minimum Structural Controls

Employ silt fences, straw bales, or sediment traps to catch sediment at the downslope boundary of the disturbed area.

Provide drainageways receiving flows from impervious areas and steep slopes with appropriate erosion controls such as riprap, matting, water bars, and/or rock check dams.

213.3 Large Sites - Over Five Acres

Construction projects disturbing areas totaling 5 acres or more are required to obtain a permit to discharge storm water from the site in accordance with the EPA’s National Pollutant Discharge Elimination System (NPDES) Stormwater Program. The NPDES General Permit requires a Storm Water Pollution Prevention (SWPP) Plan, which describes soil disturbing activities and the measures and controls to reduce or eliminate the discharge of pollutants from the site through storm water runoff.

Use the following procedures to implement the storm water program requirements for LANL construction sites requiring an NPDES permit. A

matrix showing the responsibilities of the A/E, Contractor, and LANL is presented in the Table 213-1.

- Prepare design drawings and specifications for required temporary and permanent storm water pollutant controls.
- Prepare a SWPP Plan for the project, employing BMPs specific to LANL.
- Include in the construction SWPP Plan reference to the requirements of any existing operational SWPP Plans which may already be effective for the Facility Management Unit (FMU) where the project is located. Inquire with the Facility Manager or the Water Quality and Hydrology Group to determine if an operational SWPP Plan exists for a site, and submit the Plan for review.

Include the following requirements in the construction specifications for the Contractor:

- Prepare a Sequence Of Operations for implementation of the SWPP Plan.
- Assist LANL in the submittal of a Notice of Termination (NOT) to the EPA after final stabilization measures are complete and when all storm water discharges from construction activity have ceased. Final stabilization is defined as the point in time when 1) all soil-disturbing activities are complete, and 2) the site has been stabilized equivalent to 70% revegetation. Equivalent stabilization measures include reseeding as well as permanent measures such as riprap, gabions and/or geotextiles.
- Inspect and maintain storm water BMPs and provide inspection reports to the LANL construction inspector on a monthly basis until the NOT is completed.

LANL responsibilities include the following:

- Reconcile any differences with the Contractor's implementation sequence and the SWPP Plan.
- Submit a Notice of Intent (NOI) to the EPA for both LANL and the Contractor at least 48 hours prior to the start of any soil-disturbing activity. A copy of the NOI will be provided to the NMED.
- Submit the NOI to the EPA and the NMED.

213.4 Large Site SWPP Plans

Develop the SWPP Plan in accordance with the NPDES Permit and guidance issued by the EPA. Incorporate the SWPP Plan in the design review documents and the bid package. A template for writing SWPP Plans is available in the PM Division's Standard Project Documents Manual.

- Project documents must include requirements for the Contractor to restore disturbed vegetation and stabilize soil slopes. See Section 202, Grading and Drainage Design and Chapter 4, Architectural,

Landscaping section.

213.5 Large Site Minimum Structural Controls

Construction specifications for structural practices are provided in LANL's Facility Construction Specifications Section 02270, Slope Protection and Erosion Control.

213.6 404/401 Permits

Provide a Section 404 Dredge and Fill Permit from the Army Corps of Engineers and a New Mexico Section 401 Water Quality Certification for any project crossing or disturbing a watercourse, regardless of size. Obtain the Permit and Certification prior to doing work in a watercourse. Appropriate BMPs are required to be provided; ordinarily this will include a prohibition of work in a watercourse when it is flowing.

A watercourse is defined as any river, creek, arroyo, canyon, draw, or wash, or any other channel having defined bed and banks with visible evidence of the occasional flow of water. In practice at LANL, this means the channels of all of the named canyons as well as any unnamed channel which has a defined bed and banks.

If the project involves disturbance within a watercourse the drawings shall clearly show the watercourse area and the BMPs required. The Water Quality and Hydrology Group shall review the BMPs and file the 404/401 Permit Application.

213.7 Contaminated Sites, ER and RCRA Sites

Discharge of storm water from Resource Conservation and Recovery Act (RCRA) sites shall comply with RCRA Permit requirements. For projects which disturb soil or cause runoff to cross a Potential Release Site (PRS), which is part of LANL's Environmental Restoration (ER) Project, specific storm water controls may be required under LANL's NPDES General Permit and regulatory agreements with the New Mexico Environment Department.

Contact the Hazardous and Solid Waste Group at 667-0666 or the Water Quality and Hydrology Group at 665-0453 for more information.

213.8 References

ESH-18 Storm Water BMP Guidance.

U.S. EPA Document 832-R-92-005, Storm Water Management for Construction Activities:

Design and Construction of Urban Storm Water Management Systems, Water Environment Federation and American Society of Civil Engineers (ASCE), Manual of Practice No. 77, 1992.

Urban Storm Drainage Criteria Manual, Vol. III - Best Management Practices, Storm Water Quality, Urban Drainage and Flood Control District, Denver, Colorado, September 1992.

Erosion Draw, Salix Applied Earthcare, Redding, CA 1996. Erosion control BMP detail package with specifications and CAD drawings.

LANL Facility Construction Specifications Section 02270, Slope Protection and Erosion Control

40 CFR 110-112, Discharge of Oil/Oil Pollution Prevention

40 CFR 122, EPA Administered Permit Programs: The National Pollutant Discharge Elimination System (NPDES)

New Mexico Water Quality Control Commission Regulations

Water Quality Standards for Interstate and Intrastate Streams in New Mexico

TABLE 213-1
RESPONSIBILITY MATRIX

ITEM		SUBMIT	REVIEW	APPROVE	IMPLEMENT
Design Drawings for Temporary Erosion and Sediment Controls	A/E	!			
	CONTR.		!		!
	LANL		!	!	
Storm Water Pollution Prevention (SWPP) Plan	A/E	!			
	CONTR.			!	!
	LANL		!	!	
Sequence Of Operations for Implementation of SWPP Plan	A/E		!		
	CONTR.	!			!
	LANL		!	!	
NPDES General Permit Application Notice of Intent (NOI)	CONTR.	!			N/A
	LANL	!	!	!	N/A
Inspection Reports	CONTR.	!			!
	LANL		!	!	!
NPDES General Permit Application Notice of Termination (NOT)	CONTR.	!			N/A
	LANL	!	!	!	N/A

Table 213-2

Sediment Entrapment Facility Limitations

	Allowable Maximum Limit		
Sediment Control Facility	Tributary Drainage Area (ac)	Tributary Slope Area (ft)	Tributary Slope Gradient
Sod filter Strips	n/a	50	6:1 (17%)
Straw Bale Barrier or Silt Fence	0.5 per 100 Lineal ft.	150	2:1 (50%)
Sediment Trap	5.0	n/a	n/a
Sediment Basin	n/a	n/a	n/a